Industrial Materials For The Future

Project Fact Sheet

Novel Modified Zeolites for Energy-Efficient Hydrocarbon Separations

Benefits

Development of the proposed technology will benefit domestic isoprene processing (Goodyear produces approximately 60% of all domestic isoprene) but may also be extended to other hydrocarbon separation processes throughout the petroleum and chemical industries.

The annual benefit to industry are estimated:

- 64 trillion Btu/year in energy savings and
- A 2400 ton increase in synthetic zeolite manufacturing.

Zeolites as adsorbents are quickly becoming the technology of choice for the petroleum and chemical industry for reduction in environmental emissions, mainly volatile arganic compounds. Zeolites are finding broad applications in industry, especially in environmentally sensitive industrial processes.

Applications

The technology is applicable in the

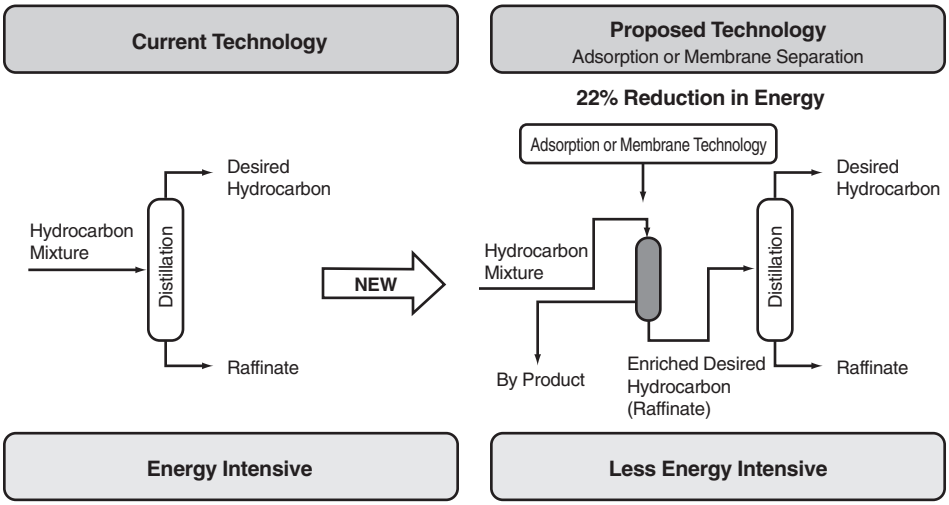
- **Chemical** and
- **Petrochemical** industries.

The impact will result in improved production efficiencies of isoprene and also in the more efficient separation of other hydrocarbons.

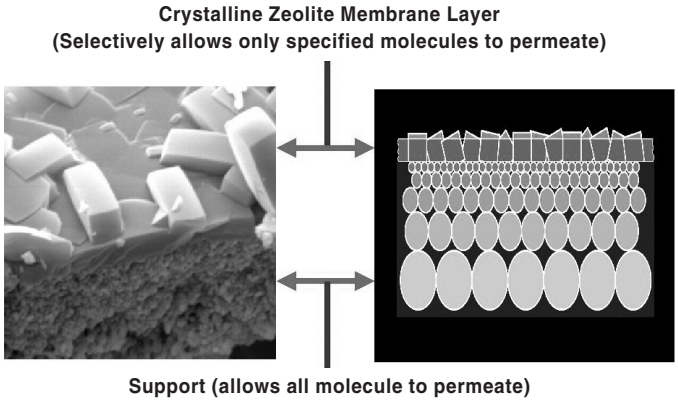
Zeolite Separation Technology Can Enable More Efficient Production of Hydrocarbons

It is anticipated that this project will provide the next generation in separation technology. These materials are designed to minimize the energy consumption and raw materials associated with current separation processes by differentiating between olefins and alkanes, and between branched and linear hydrocarbons based upon differences in adsorption properties and molecule size.

Novel modified zeolites for energy-efficient hydrocarbon separations will be developed in this project. Controlled surface and framework modification of zeolites is the focus. A successful research project will create an enabling technology for future adsorbents, materials for membranes, and the potential development of shape-selective catalysts.



Current vs proposed hybrid technology for the separation of isoprene from a C5 mixture.



Zeolites as membranes

Project Description

Goal: The goals of this project are to
– Develop methods to selectively modify the sorptive properties of known zeolites.
– Create new adsorbents by modification of known zeolites.
– Allow adsorbent-based hydrocarbons separation processes to replace energy-intensive and energy inefficient processes such as distillation.
– Create the basis of a predictive model so that, via this technology, adsorbents may be tailored for particular processes.

Issues: During the last two decades, the domestic industry has performed limited research and development into the area of controlled surface and framework modification of zeolites for adsorption and membrane-based hydrocarbon separations. The successes associated with the research and development of zeolite modification for hydrocarbon has been limited because of the large technological gap between the novel material developers and the requirements of the hydrocarbon-processing industry.

This project will require the development of carbon-modified zeolites to allow new and energy-efficient adsorption-based separations. This effort is based on successful preliminary work performed.

Approach: The project is divided into three major phases. The first phase is to determine the relationship between zeolite type and carbon source and to optimize carbon deposition parameters. The second phase is to complete industrial pilot plant testing of carbon modified zeolites. The third phase is to perform engineering analysis and feedback of the proposed technology. The tasks include
– Determining zeolite type and carbon source relationships,
– Industrial pilot plant testing of carbon modified zeolites, and
– Engineering analysis and feedback.

Potential payoff: Currently, olefins are prepared by catalytic thermal cracking of saturated hydrocarbons. In the United States alone, 53 billion pounds of ethylene, 39 billion pounds of propylene, 4 billion pounds of butadiene, and 435 million pounds of isoprene are produced annually. The use of zeolites can have significant benefits on the energy efficiency of these processes.

This affords a huge opportunity to develop materials that will advance the current state of the art in hydrocarbon separations based on adsorbents and membranes. These separation technologies could result in a 22% reduction in energy for the aforementioned hydrocarbon purifications, which translates into an energy savings of 64 trillion Btu/year.

Progress and Milestones

- Characterize materials by surface area and chemical analysis.
- Perform separation experiments on materials that display selective adsorption of isoprene.
- Determine best zeolite-carbon deposition condition combination via separation experiments.
- Synthesize a sufficient quantity of material for testing.
- Test optimized carbon modified zeolite in a pilot plant.
- Conduct lifetime studies, including regeneration and desorption.
- Begin engineering studies from preliminary results.
- Complete detailed computer process modeling simulations.
- Complete engineering analysis with regard to feasibility of membrane process.

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